

Ammonia

Q1 Why is the Haber Process so important?

Q2 The two gases used to make ammonia in the Haber Process are hydrogen and nitrogen.

a) Where does the nitrogen come from?

b) Where does the hydrogen come from?

Q3 Look at the diagram opposite.

a) Why is the iron catalyst on large trays?

b) How does this affect the reaction?

c) What is the function of the condenser?

d) Why is the reaction at a temperature of 450°C and a pressure of 200 atmospheres?

e) How would a very low temperature affect the rate of this reaction?

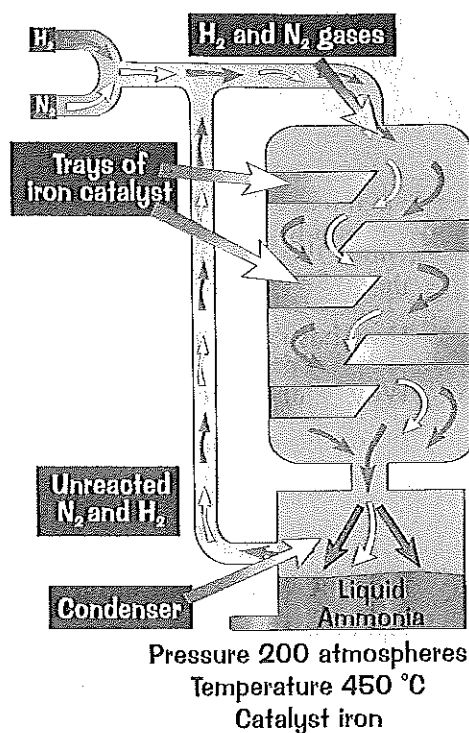
f) Nitrogen + Hydrogen \rightleftharpoons Ammonia.

i) Write this equation in symbols and balance it.

ii) What does the symbol " \rightleftharpoons " mean?

g) Not all the nitrogen and hydrogen that enter end up as Ammonia.

Why is this and how is it compensated for?



Q4 The production of ammonia on an industrial scale needs to be economical.

The temperature and pressure can be chosen to maximise the yield.

Explain why the reaction is not carried out at even higher pressures when this would increase the yield more.

Q5 Complete the following paragraphs by filling in the missing words from the list below. The words may be used once, more than once or not at all.

450	1000	ammonia	molecule	hydrogen	nitrogen	molecules
200	fertilisers	unreacted	Haber Process	recycled	pressure	

_____ is manufactured by the _____. One use for ammonia is in the making of _____. The gases _____ and _____ are brought together under the special conditions of _____ °C and a _____ of _____ atmospheres. Nothing is wasted — any _____ hydrogen and nitrogen is _____. Hydrogen and nitrogen combine in a ratio of 3 _____ of _____ to 1 _____ of _____.

Q6 In the production of ammonia, the yield increases as the pressure is increased. However, at a given pressure — the lower the temperature, the greater the yield.

a) Using the data given in the table opposite, plot a graph of the variation of yield with pressure when the temperature is kept at 450°C.

b) On the graph, sketch a second line showing the yields of ammonia you would expect at 350°C.

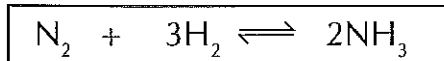
c) Why is a lower temperature not used in ammonia production?

Pressure of reaction at 450°C (atm)	Approx. yield of ammonia (% volume)
100	10
200	25
300	40
400	45

Q7.

The reaction that produces ammonia is as follows:

Nitrogen + Hydrogen \rightleftharpoons Ammonia



- a) This reaction is exothermic. What does this mean?
- b) If you increase the pressure, what will happen to the yield of ammonia?
- c) If the temperature is raised, the yield of ammonia is decreased, but the rate of reaction is much higher. Why is this?
- d) The temperature in this industrial process is chosen to be high, although the yield is lower than it could be at a lower temperature. Explain why such a high temperature is chosen.
- e) A high pressure will give an increased yield and an increase in the rate of reaction. Explain this statement in terms of particles, gases and the collision theory.
- f) Iron is the catalyst used in this reaction. Why is it so important to have a catalyst?